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Tenth day of December 2003

LEANNE MYNOTT
MANAGER EXAMINATION SUPPORT
AND SALES

SEALED CAPACITIVE PRESSURE SENSOR FOR NON-INVASIVE BLOOD PRESSURE MONITOR

FIELD OF THE INVENTION

The present invention relates to the field of blood pressure monitors and, in particular to, an oscillometric blood pressure monitor which measures air pressure using a capacitive pressure sensor.

BACKGROUND OF THE INVENTION

Oscillometric blood pressure monitors calculate blood pressure values using analysis of air pressure fluctuations transmitted from an arm cuff to a pressure sensor.

Low cost blood pressure monitors use capacitive pressure sensors composed of two parallel metal plates that form a capacitor. Distance between the capacitor plates and their area define capacitance of the capacitor. While the area of the plates remains constant, the distance between the plates is variable and proportional to external pressure applied to one of the plates of the capacitor. The capacitor defines frequency of the electronic oscillator. The frequency of the oscillator is inversely proportional to the pressure applied to the sensor pressure. An air gap separates the plates of the capacitor.

Properties of the capacitor dielectric or air gap in the capacitive pressure sensor affect its capacity. Changes in humidity and temperature change dielectric properties of the air and in turn, capacitance of the pressure sensor. Variations in humidity lead to a different rate of oxidation of the metal surface of the capacitor plates. These unwanted long term changes of the capacitance of the pressure sensor are very difficult to predict and compensate. This makes capacitive pressure transducers less reliable.

It will be an advantage to provide a sealed air gap in the capacitive pressure transducer in order to eliminate effects of the humidity variations in digital blood pressure monitors.

It is believed that improvements in accuracy of a capacitive pressure monitor can be achieved by providing a constant humidity air gap. It is also believed that it would be advantageous to provide a sensor whereby reliability is increased as well as lowering manufacturing costs.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a non-invasive oscillometric blood pressure monitor which substantially overcomes or ameliorates the above mentioned

disadvantages. At the very least, the invention provides an alternative to previously known monitors.

DISCLOSURE OF THE INVENTION

According to one aspect of the present invention, there is disclosed a a sealed capacitive pressure sensor having a body with a first chamber and a second chamber, said first chamber having an air inlet and at least one opening into said second chamber; a flexible membrane means located in said first chamber to form two sealed cavities in said body, a first said cavity being formed between said air inlet and said flexible membrane and a second said cavity being formed by space in said first chamber on other side of said flexible membrane and the space in said second chamber; a capacitor located in said second cavity within the first chamber portion of said second cavity, said capacitor being formed by a pair of electrodes adapted to have variable relative spacing between them according to the air pressure within said first cavity, wherein the air pressure within the second cavity equalises between the first chamber portion and the second chamber portion of the said second cavity due to due to movement of air through said at least one opening.

Preferably, the capacitor is formed from a stationery disc electrode fixed to a wall of the first chamber and a disc spring electrode in a plane spaced apart from the stationery disc electrode , and with the disc of the spring being adapted move relative to the position of the stationery disc electrode.

Preferably, the flexible membrane is adapted to abut against the disc of the spring.

Preferably, the wall between the two chambers is formed by a printed circuit board, the stationery disc electrode being attached to or being part of the printed circuit board with the spring electrode being connected directed to the printed circuit board and therefore having direct contact.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of the invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a partial transverse cross section view of a typical capacitive pressure transducer of the prior art;

Fig. 2 is a partial transverse cross sectional view of a capacitive pressure transducer according to one embodiment of the present invention;

Fig. 3 is a plan view of a spring used in the transducer of Fig. 2; and

Fig. 4 is a transverse cross sectional view of the spring of Fig. 3.

BEST MODE OF CARRYING OUT THE INVENTION

Referring to Fig.1, a typical capacitive pressure transducer 10 is shown. The pressure transducer 10 is mounted on a printed circuit board 11. A top plate 12 of a capacitor 13 is located by spacers 14, screws 15 and nuts 16 parallel to the printed circuit board 11. A second plate 17 of the capacitor 13 is attached to a flexible membrane 18 of a sealed chamber 19. The sealed chamber 19 is attached to the printed circuit board by the aid of the screws (not shown). An air inlet 20 is connected to the pneumatic circuit of the blood pressure monitor. When air pressure is applied to the chamber 19 via the air inlet 20, the flexible membrane 18 expands and moves plate 17 towards the top plate 12. When the air pressure is removed, the plate 17 returns to its original position. The capacitor plates 12 and 17 are connected to an electronic oscillator 21 via wires 22 and 23, respectively.

As it can be seen, this type of construction presents significant problems to seal the air gap of the capacitor in order to control humidity between plates 12 and 17.

Manufacturing of the described above pressure transducer 10 requires precision stamping of the membrane 18, welding 24 of the sealed chamber 19, and precision soldering of the bottom plate 17. Assembly of this transducer 10 also requires an extensive expert labour.

Referring to Fig. 2, a pressure transducer 30 of the preferred embodiment of the present invention is shown. The pressure transducer 30 is mounted on a printed circuit board 31 and has two sealed cavities, namely, a top cavity 32 being formed by a top cap 33 and the top section of a H-shaped flexible rubber like membrane 34, and a second sealed cavity 35 being formed by the bottom section of the H-shaped rubber membrane 34 and the printed circuit board 31 forming a first portion 36 of the cavity 35, a bottom cap 37 and a flexible rubber-like sealing ring 38 forming a second portion 39 of the cavity 35. When the transducer 30 is assembled, the H-shaped membrane 34 and sealing ring 37 are compressed, providing reliable sealing. The two portions 36 and 39 of the cavity 37 are joined by a hole 40 in the PCB 31.

A capacitor 41 is formed by a first plate 42 formed by a round copper layer of the PCB 31 and a second plate 43 formed by a spring which is soldered to the PCB 31. The transducer 30 has an air inlet 44 into the top cavity 30.

The transducer 30 operates such that when air pressure from a pneumatic circuit of the blood pressure monitor (not illustrated) is applied to the pressure transducer 30 via the inlet 44, the air pressure pushes the spring 43 via the flexible membrane 34. The flat surface of

the spring 43 will move towards the bottom plate 42 of the capacitor 41 changing its capacitance. While the membrane 34 is pushed down by the external pressure and the spring 43 is compressed, the volume of the bottom cavity 35 is decreasing, creating an internal pressure. This internal pressure is in linear proportion with the displacement of the membrane 34, therefore it does not affect the overall linearity of the pressure transducer 30. However, in order to achieve high sensitivity of the pressure transducer 30, internal pressure resistance is minimized by the use of the large portion 39 of the bottom cavity 35 located below the PCB 31. Further extension of the bottom cavity 35 would make influence of the internal pressure negligible.

Furthermore, the transducer 30 further includes a small compartment 45 contains an agent 46 that absorbs the moisture inside the bottom cavity 36.

Electrical connection of the capacitor plates does not require connecting wires because both plates have direct contact with the PCB copper deposit.

The transducer is preferably assembled using snap-feet latches.

Referring to the Figs. 3 and 4, the spring construction is shown. The springs 43 are punched from bronze-beryllium or bronze-manganese sheets.

The construction includes massive disk 47 that serves as a top plate of the capacitor. Three legs 48 are formed as flexible springs as shown on Fig. 4.. Solder terminals 49 are folded as shown in Fig. 4. The spring 43 is soldered to the PCB 31.

As it can be seen, construction of the pressure transducer 30 uses low cost components and does not require precision assembly or adjustments.

Throughout the specification, the word "comprise" and its derivatives are intended to have an inclusive rather than an exclusive meaning unless the context requires otherwise.

The foregoing describes only some embodiments of the present invention, and modifications obvious to those skilled in the art can be made thereto without departing from the scope of the present invention.

Dated this 26th day of November 2002

Vladimir Jankov, Harry Louis Platt and Allan Michael Shell

Patent Attorneys for the Applicant

CHYSILIOU LAW

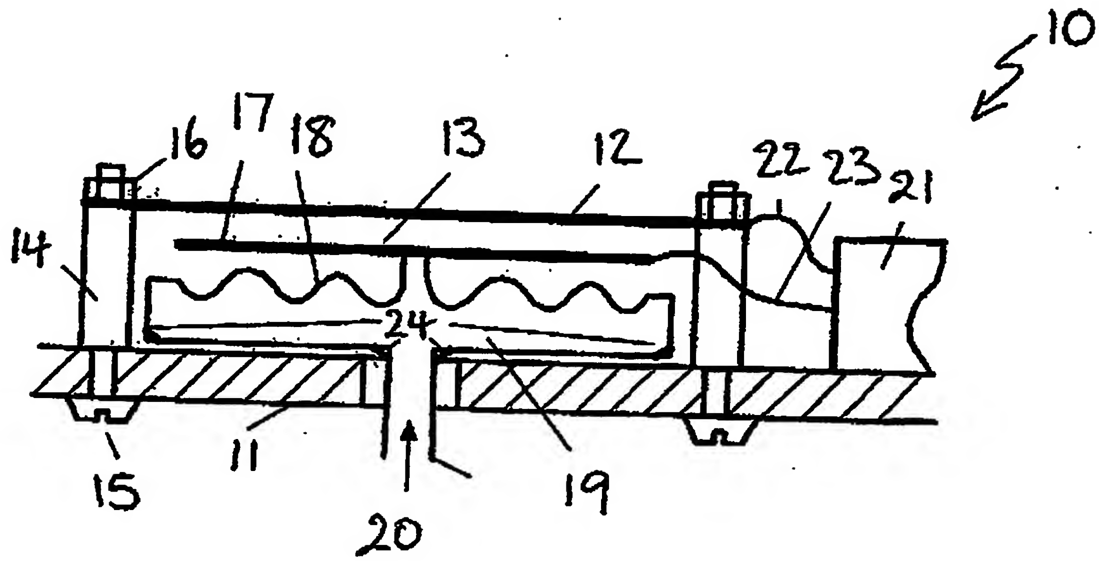
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FIG. 1

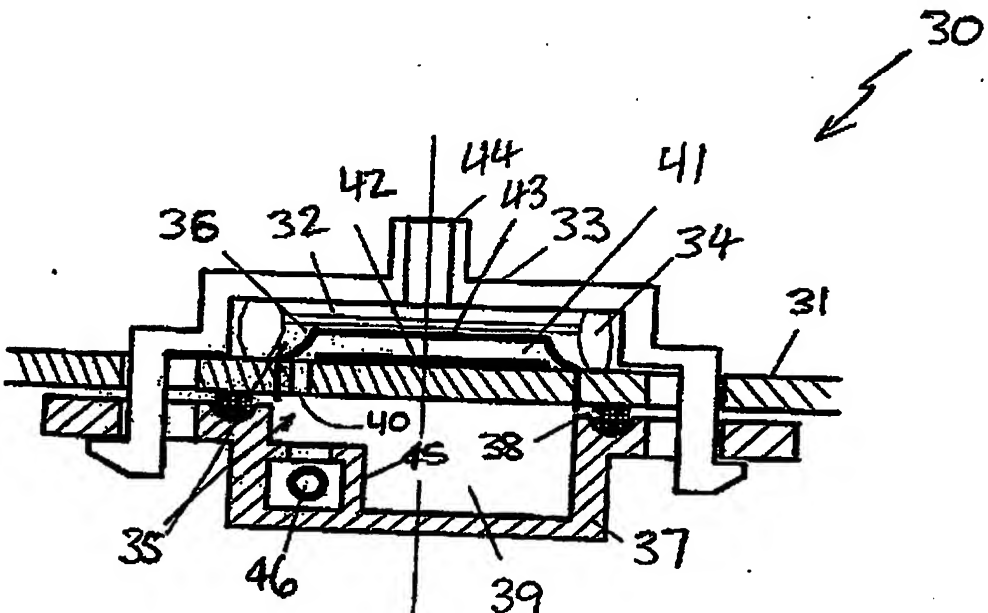
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FIG. 2

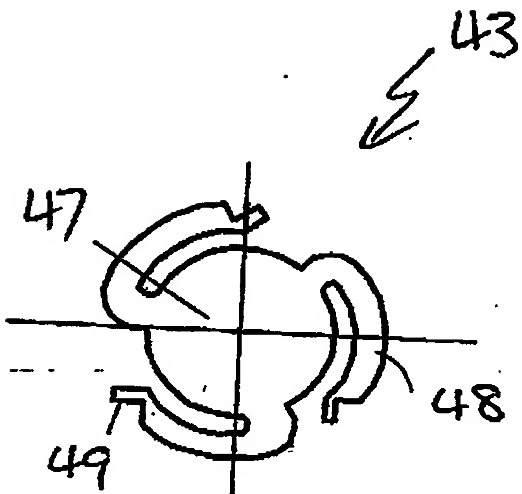

Fig. 3

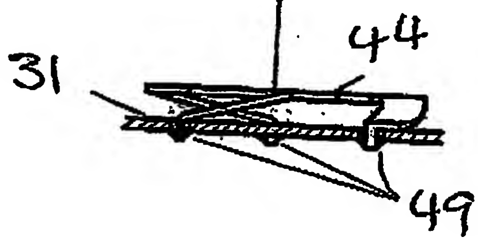

Fig. 4